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portant studies of the American Republic by foreign hands. It examines very carefully our whole governmental structure, Federal and State, and the social economy and political foundations on which the edifice rests."—*The Kindergarten*, Chicago, is fulfilling its claims to give to mothers of young children methods of amusement combined with instruction. 'Nursery Occupations' and 'Typical Lessons,' in the October issue, give practical hints that alone would pay the price of subscription.—*The English Illustrated Magazine*, published by Macmillan & Co., is to be enlarged to seventy pages, the price remaining the same (15 cents).—Edward Meeks, Philadelphia, has in preparation a second edition of Roper's 'Handbook of Modern Steam Fire-Engines.'—'Gardner's School Buildings' (E. L. Kellogg & Co., 25 Clinton Place, New York) will be out this week; also (by same publishers) No. 11 of Teacher's Manual Series, entitled 'The Argument for Manual Training,' by Dr. Nicholas Murray Butler.—In the *Overland Monthly* for October is a paper on fog and fog-signals on the coast, by Mr. F. L. Clarke, who developed some facts of importance to seafarers on 'areas of inaudibility' of signals.—The *New York World* has in preparation 'The World Almanac for 1889.'

## LETTERS TO THE EDITOR.

Kiessling's Twilight Phenomena.<sup>1</sup>

SIMULTANEOUSLY with the publication of the 'Royal Society's Report upon the Krakatoa Disaster and its Results,' comes the most important German contribution to that section of the subject treating of the abnormal glows, — a subject which occupies two-thirds of the 'Royal Society Report,' of nearly five hundred pages. The bulk of the contained matter is nearly equal in the two books; but it is drawn from such diverse sources, and the views propounded in the theoretical parts are so different, that only a small proportion of the whole appears in duplicate. The beautiful colored plates in each curiously support the main theory of the book, their fidelity to nature indicating the probability that the diffractive effects advocated by Professor Kiessling and the reflection upheld by the 'Royal Society Report,' each have a share in the final result.

The historical introduction deals with the study of twilight phenomena: Von Bezold's admirable summary (the work is dedicated to the distinguished director of the Berlin Royal Meteorological Institute) is given in detail. The work is then divided into two parts, four sections treating mainly of observations, and two of experiment and conclusions.

Section I. gives a detailed list of glows in forty-four years, noting any coincidences with earthquakes and eruptions. The three opening dates are 989, 1117, and 1554. There are at least seven earthquake coincidences, the associated glows being strictly local. The 'Royal Society Report's' list is of the one hundred and fifty-five chief volcanic eruptions since 1500, and glows (thirty-one in all), in parallel columns. Thirty of the latter coincide with eruption years, which number is increased nearly one-half by Kiessling's tables. Most worthy of notice is the remarkable completeness of detail concerning the European glows after the eruption of Graham's Island, near Sicily, which was also submarine.

Section II. largely occupies the ground of the 'Royal Society Report,' Part IV. Sect. II., both being lists of special appearances since Aug. 26, 1888, approaching nine hundred each in number. The former, however, continue on to the close in 1886, while the latter are chiefly confined to 1883. The immense amount of valuable records obtained from the ships' logs of the two countries is very striking. It will be a great pity if similar work is not performed in connection with the merchant marine of North America. The North American land-returns have been copiously drawn upon, especially by Professor Kiessling, thanks to the *Monthly Weather Review*; but here, again, there must be a rich store of private records awaiting collation.

Four excellent maps, for Aug. 26 to Sept. 30, for October, November, and December, 1883, contain localities, with dates, for the glows, by which their progress can be easily traced. With the same object in view, the records in the list, up to the close of No-

vember, are arranged in four parallel columns, according to longitude.

Professor Kiessling throughout treats the bright 'glory' round the sun, known as 'Bishop's ring,' as the most important phase of the glows. Section III. describes its appearance, spread, and changes, the explanation forming an important portion of the second part. His already published and generally accepted explanation of it by diffraction is there supported by a most interesting series of experiments. The equally unique appearance of the counter-bow, at the point opposite the sun directly after sunset, he thinks is to be regarded as of similar origin. This was noted in Europe almost simultaneously with the glows: on Nov. 27, 1883, and Dec. 15 and 20, at Sunderland, by Mr. T. W. Backhouse; Dec. 22, 1883 (not 1884 as misprinted in 'Warner's Prize Essays,' p. 40), by L. Richardson at Newcastle; on Dec. 29 to Jan. 3, by Herr Jesse Steglitz; and on Jan. 12, 1884, by the writer. Measurements by the first and last prove identical with those of Bishop's ring. As most people chiefly regard the rising or setting sun, the anti-solar phases escape observation. Hence all observations of the counter-bow would specially repay collation.

In Section IV. Professor Kiessling, dealing with the outspread of the glows, shows that the originating cloud-haze must have consisted at first of distinct streams, the probable courses of some of which he indicates. The velocities of outflow he fixes at between sixty-seven and eighty-nine miles per hour, as against seventy to eighty-four, the extreme values deduced in the 'Royal Society Report.' Both conclude that the height, for Europe, was about twelve miles.

The artificial formation by diffraction in dust, condensed vapors, etc., forms the subject of Section V., which opens the second part, and his simple but effective experiments deserve wide repetition and development. Incidentally capital illustrations are given of cloud-formation. His previous publications upon this subject are considerably expanded, and fresh applications made. As already stated, they form the main basis of his contention for diffraction as the paramount cause of all the phases of the glows, admitting, however, reflection as a subsidiary agent. His method of treating the glow-colors concentric to the sun apart from the glow-colors parallel to the horizon, upon which, during the twilight, the former are superposed, greatly simplifies their elucidation. Probably his arguments as regards the former class will be regarded as the more convincing, especially as diffraction so obviously explains Bishop's ring. As to the horizontal layers, no doubt diffraction plays a considerable part, but as certainly Messrs. Russell and Archibald, in the 'Royal Society Report,' rightly uphold reflection as the main factor. In this they are supported by Professor Ricco. Of the various objections brought forward by the latter, two may be noted. Professor Kiessling accepts the interposition of clouds or mountain-peaks as the cause of the dark bars often dividing the first glow; but this could hardly apply if the main light is due to diffraction. Again: with the others he considers the second glow to be a reflection by the haze-layer of the first. Such a surface, then, would surely reflect direct sunlight as well.

To some of the objections, however, the present work indicates Professor Kiessling's probable reply; as, the possibility of the dust-haze so quickly assuming the homogeneity required by his theory, and the occasional appearance of day and twilight glows independently. We may also notice that he ascribes the haze-cloud chiefly to condensation products, while the 'Royal Society Report' favors mirror-like surfaces from microscopic pumiceous bubbles, — conditions in each case in harmony with the adopted theory. The discussion of tropical sunsets at Loango and in South America provides Professor Kiessling with several strong points, for in these instances he is able to show a remarkable agreement between observation and experiment. The excellent colored sketches by Dr. Pechel-Loesche are here a material assistance.

The general arrangement of this valuable work is well adapted for reference. Only one misprint of any moment has been noted: on p. 55, § 44, "110°O" should apparently be "120°O," or the "Middle Dog" Lighthouse lies some distance inland in China. The printing is most exquisitely clear, which is no small boon, for the title is not the only word, which, to eyes accustomed chiefly to English words, are almost appallingly long.

J. EDMUND CLARK.

<sup>1</sup> Untersuchungen über Dämmerungserscheinungen, zur Erklärung der nach dem Krakatau-ausbruch beobachteten atmosphärisch-optischen Störung, von J. Kiessling. Hamburg and Leipzig, Leopold Voss, 1888.